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The above List is prepared from the Patent Records by Mr. T. Morgan, Secretary of the Inventors' Patentright Association, Limited.

A SONG OF MAY.

O LET us sing a song of May,
Now spring puts forth her tender flowers,
And pipes the thrush midst sunny hours;
O let us sing a song to-day!

O let us roam thro' glen and glade,
Our matins chant this sweet May morn;
For nature with new life is born—
We'll seek the silent woodland shade!

The light wind sweeps the upland wold,
And moves the hedge-rows as we pass;
The daisies blossom in the grass,
The fields are like a cloth of gold.

Here, soft and low, the gentle voice
Of nature whispers thro' the trees:
While loll the blue-bells on the breeze,
And all the birds with songs rejoice!

The leaves are fresh with early showers,
The rain drops glisten in the grass,
Now slowly waving as we pass;
The banks are rich with budding flowers.

The lark sings, hov'ring o'er her brood;
The cuckoo calls in plaintive strain;
Nor chants the nightingale in vain;
The black-bird warbles in the wood.

The music and the bloom of spring
Are joys to us which few can tell;
The sights and sounds we love so well,
Steal softly as an angel's wing.

We live within a school of thought,
That God is found where'er we go:
And this, the grandest truth we know,
Has made all else, in living, naught.

The light our spirits now release
Will yield a harvest in the years,
And death to us so free from fears
Will bring its own eternal peace,

You take the brush, while I indite,
We let our souls with nature flow:
And thus to life we give a glow,
And live in a more perfect light.

O let us sing, for life is ours,
While passing thro' this transient sphere,
And all the good we strive for here
Will crush the thorns and give the flowers!

HENRY GEORGE HELLON.

Reviews.

METALS.

"Metals; Their Properties and Treatment," By Charles Loudon Bloxam, Professor of Chemistry in King's College, London, in the Department of Artillery Studies, and formerly in the Royal Military Academy, Woolwich. New Edition. Partially rewritten and augmented by Alfred K. Huntington, Professor of Metallurgy in King's College, London, and Lecturer on Metallurgy to the Medical School of the Dental Hospital of London. London: Longmans, Green, and Co.

This is a New Edition of the work on Metals which forms one of the series of the excellent Text Books of Science which we have before had occasion to bring under the notice of our readers.

To show the important strides made during the past few years we cannot do better than quote from the preface of the present edition which states that, "Owing to the important changes which have taken place in the metallurgy of iron since this work was first published, it has been found necessary to rewrite entirely the portion relating to that subject. In doing this the opportunity has been taken to break down the unnatural barrier which in text-books usually exists between iron and steel. In the comparatively limited space available for the purpose it has been attempted to give a clear and consecutive account of the principles upon which this industry of unsurpassed importance is based.

Since the successful extraction and treatment of metals for the most part depends on the nature and supply of *fuel* and *refractory materials*, no hesitation has been felt in introducing chapters on these subjects into the present edition. No book on metallurgy would be complete without them.

The greater importance which *nickel* and *cobalt* have recently assumed fully warrants the insertion of the few pages concerning them.

The remaining alterations and additions do not call for special comment. It will doubtless be thought by some that many recent processes which have not been mentioned—the greater part only modifications of existing methods—should have received notice. Many a process which is heralded with great trumpetings to-day, in two or three short years gives place to some other equally pretentious claimant, and is heard no more of. So must it ever be. I do not flinch from taking the responsibility of all such omissions, holding as I do, that nothing until it has stood the test of time, should find place in a work of this nature."

The author acknowledges valuable assistance rendered by Mr. W. Terrill in the revision of copper, and also to his assistant, Mr. W. G. McMillan, for revision of proof sheets, and making the index.

The work we cordially commend to our readers.

AGRICULTURE.
GEOGRAPHICAL READERS.

"Elementary Principles of Agriculture for Class-Teaching According to the Requirements of the Latest Code." By Albert Carey, F.R.G.S., author of "Principles of Agriculture," &c. London: Thomas Murby, 3, Ludgate Circus Buildings, E.C., and all Booksellers.

"Plans, Maps, and Points of Direction." London: Thomas Murby, 3, Ludgate Circus Buildings, E.C., and all Booksellers.

These little books will no doubt be of value for the purpose for which they are designed, viz., to meet the requirements of the latest educational code.

IMPROVEMENTS IN VALVES.

By T. Morgan.

(A Paper read before the Inventors' Institute, May 10, 1883.)

It may seem to the members and gentlemen present that the subject of this paper is of very little importance to those outside the trade, and although the subject may seem of that character, yet I venture to think it is a matter of almost national importance, seeing that without valves nothing can be controlled in water, gas, or liquids.

The vast number of inventions bearing on the subject of valves may convince, or be presumed to convince, inventors that nothing further can be done to improve the valves in any service or machinery.

This, I think, is not the fact, as recent inventions go to prove, as, for instance, the fitting of the valves so as to avoid breaking of joints.

There is, however, one great feature which was overlooked till a very recent period, to which I wish specially to draw attention.

Valves, like all portions of mechanism, require to be replaced to be worked, when by some accident or design their action is affected.

In this particular, as I have said in recent years, attempts have been made; but up to a short time ago with, I think, very indifferent results.

The improvements since made by the patentee, to whom I specially refer, have I think almost effectually solved the problem, and a great stride has been made, as results have proved.

The invention I particularly refer to is that of Mr. G. Teideman, who, I regret to say, is not here this evening owing to illness.

It is not the practice of this Institute to devote to one of its members an evening without bringing forward previous inventions which bear on the same subject; and, as I have already stated, the important addition to cocks or valves in adapting liners or false plugs is of practically recent date.

So far as I am aware, there are but few patents secured, and I think it would be for the benefit of the meeting that I should describe those found to have a bearing on the matter, and then describe that for which I specially ask the criticism of the meeting.

One of the first is that by Mr. Bailey, the well known manufacturer in Manchester, and was secured in 1878.

These improvements consist in the construction of cocks and taps, the repair of the working parts of the same being effected without removing the body of the cock from the piping into which it has once been fixed, and thus without breaking the joints.

This object is accomplished by inserting in and attaching to the body of the cock or tap a sleeve or lining, or casing, having an opening or passage corresponding to the bore of the pipe. Into this casing is inserted the usual plug, which, by preference is hollowed out, so that the passing fluid moves downward into a cavity in the casing provided for that purpose, and thence flows onward into the continuation of the piping. When the lining, sleeve, or casing is worn out it may be lifted out of the body of the cock or tap and replaced by a new one, which, being manufactured on the interchangeable principle, is a duplicate of the worn one, and which may be kept ready for the occasion.

In order to equalize the temperature of the lining and the plug, an annular space is formed between the lining and the body of the cock, which space will be filled with the passing fluid. In the ordinary cock the fluid has access to the plug only, and raises it to a high temperature, while the body of the cock, being exposed to the atmosphere, remains at a much lower temperature, and the result is an increased pressure on the circumference of the plug, consequently causing unnecessary wear and tear.

The body of the cock may be made of the same material as the plug and lining, but for the large cocks it is preferred to make the body of cast iron, while the plug and lining are of brass.

The special features of the arrangement is—

Inserting in the body of a tap or cock a lining or casing of brass or other suitable material, in which the plug turns, and which may be removed and replaced by another casing without disconnecting the body of the cock from the tubes.

Hollowing the surface of the lining or the adjoining surface of the body in such a manner as to form a cavity that will admit the fluid with which the main pipe is filled, and thus equalize the temperature of plug and lining.

This Invention, no doubt, so far as the false plug and liner is concerned, to a certain extent is somewhat similar to that of the models submitted, but, I venture to say, are of such a character as to show a great improvement.

For a like result, so far as repairing under pressure is concerned and the breaking of joints, another arrangement recently patented is that of Messrs. Furness and Robertshaw. The description of this arrangement is as follow:—

Valves, small and large, for steam, water, and gas, have received much attention at the hands of engineers and brass finishers. Judging by the number of forms in the market, each put forward to overcome some real or fancied defect or to obviate some drawback in working, it would appear that valves in general have to work under the most onerous mechanical or chemical conditions. It is, however, the fact that this is very largely the case. In some trades, notably in the dyeing, printing, and finishing of textile fabrics, the consumption of these articles is very considerable, so much so that by some firms they are ordered as a regular thing dozens at a time, and passed into the stores for use when called for, which use is generally to replace a leaky and past-repair sort of article.

It embodies at least two very good points, viz., its interior can be readily got at for examination and repair, and also without breaking or unscrewing its joints with the line of piping. There is further a facility of altering the kind of valves proper, to which The upper part of this valve, containing stuffing box, screwed spindle, and the valve, is bolted by four bolts to the bottom or seat portion of the valve which is attached to the line of piping. The joint thus made is a face joint, with a square flange, the holding bolts being at the corners. Suppose the upper portion is detached, the seat of the valve being higher than the face joint may, if corroded or leaky, be filed across and the mitre scraped true *in situ* with the greatest facility, and without special tools. The valve may be flat face knife edge, re-sharpening or mitre as required. A valve with a sunk recess intended to receive a disc of india-rubber, felt, gutta-percha, vulcanized fibre, asbestos, or any material that may be desired for use can be employed. Some materials answer better than others for certain liquids. The discs or washers are, of course, screwed down upon a flat seat. It is claimed as a good feature that this valve permits of their easy renewal. A further advantage is that the wings for guiding the valve do not work in the seating, limiting its area and being liable to stick from canting to one side. They are placed above the valve, and work in a recess bored to receive them. Save when otherwise required, the valve is loose and independent of the spindle, and is thus suitable for a back pressure valve or as a pump.

Another Patent, secured by a Mr. Osborne, as described relates first to improvements in the arrangement and construction of high pressure taps or valves, in which a stop or additional valve is applied to the underside of a tap for the purpose of cutting off the supply or passage of water or fluid through the ordinary valve and passage of the tap when desired to avoid the necessity of water companies turning off the water from the main during alterations or repairs, or to admit of the tap itself being repaired, thereby saving labour, expense, and waste.

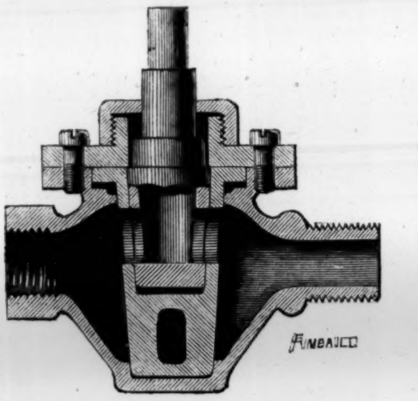
In the arrangement of the tap and valve above referred to, the additional stop valve was placed on the underside of the ordinary passage and valve of the tap, and much trouble and inconvenience is experienced in getting at the stem or spindle of the valve to close or open it when required.

In order to obviate this difficulty, an additional or stop valve is placed near to or alongside of the stem of the ordinary valve on upper or the front side of the passage of the tap and find it advantageous to place the stem of the stop valve at an angle to the stem or plug of the ordinary valve, so that the former can be readily turned to close or open the valve when required.

The construction of the tap and of the stop or additional valve may be considerably varied, and the latter may be applied to ball and other taps to cut off or regulate the flow of water or other fluid through the same.

I will now proceed to describe the special improvements for which Patents have been secured by Mr. Teideman.

The Invention as described states its object is improvements in cocks or valves applicable for water, steam, gas, or other fluid, and is specially applicable for use where the cock or valve leaks or requires repairs, the same being effected according to this Invention without interfering with the cock or valve.



The plug of the cock or valve may be formed or constructed in the ordinary way, with a lining or liner or false plug between the body and the said plug. The liner of false plug is formed with suitable openings corresponding with the shell or body, and also openings at the lower part at right or other angles with that in the plug, corresponding with those in the body.

The cock or valve works in the ordinary way, but when from leakage or otherwise the plug or valve is withdrawn, the false plug or liner is also turned, thus opening communication with the lower opening in the liner, and the cock or valve is worked in the same way as with the plug, which, when reinserted and the false plug turned, communication is again effected through the plug of the cock or valve.

The Invention is also applicable to three or four way cocks or valves, all that is required being the adjustment of the openings in the plug and false plug at their proper angles and position. The liner can be adjusted by screw or otherwise to the required openings or portways.

The liner can be used independently of a double opening, and as a one way cock.

From this description and the models it will be clear to you, I am sure, that there is great merit in these improvements.

There are other points that I should wish to refer to. As regards Asbestos packing, this has been before used, and is used by Messrs. Dewrance, patented in 1874. The rearrangement of packing, however, in an Invention is not affected in the Patent under notice, the purpose being in each case different.

In conclusion the claims made for the improvements over those before secured and enumerated, Mr. Teideman holds that his valve is the first introduced to enable the service to be kept through the pipes while effecting repairs to the cocks or valves. The body or shell is permanent, not requiring renewing when once adjusted. It is applicable for cocks or valves for all purposes. It may be used with packing between the outer shell and liner to prevent sticking, should it remain long without requiring use, and also to prevent grinding in, so that outer plugs may be kept in stock, turned to a gauge, and cushioned upon existing packing. By introducing this new application of an adjustable liner or false plug, a new combination is made, all useful arrangements now in use being adapted to the liner or false plug.

There are several patents now in force that have aimed at the same result, but have not been developed to the same extent. The Inventor has aimed at preventing breaking joints, and continuing supply under pressure and when repairing.

CREOSOTE—ITS TESTS AND ACTION.

By M. Hager.

I HAVE previously written on the curative value of creosote and the preparation of creosote pills. Now that we are able to procure and dispense genuine creosote from beechwood tar, I take the liberty of again treating the subject from a therapeutical and chemical point of view.

Camboulives, a French physician, warns us in his "Manuel Pratique de la Therapeutique," to distinguish well between creosote and phenol (carbolic acid), as the former from beech-wood tar was destined to play a great part in therapeutics, owing to its powerful action. More than this; it coagulates albumen, has the property of preserving animal substances for a long time, and being antiseptic, anatomical preparations can be kept in a lasting state of preservation.

But creosote has other virtues, owing to its causticity and astringent power. When put in contact with the skin, it produces wounds that are similar to burns, and pain like them. On account of its corrosive power it is much used to kill the tooth nerve in toothache. When diluted it is no longer caustic, but becomes astringent. Taken inwardly in moderate doses it develops a feeling of warmth in the stomach with sour eructations, &c. When it has passed into the blood circulation, it tightens the capillaries, and decreases the mucous flow both in the bladder and the air passages.

Camboulives remarks further: "This medicament has enjoyed an undeserved reputation since its discovery, for people were soon convinced that it was only useful for carious teeth and toothache." Nevertheless, Bouchard and Gimbert endeavoured to restore its reputation as a curative agent, and they administered in pulmonary consumption, &c. Their experiments were successful, and they have published a long list of their observations, to the effect that creosote, after being administered for a week or two, has the effect of decreasing the expectoration, lessening the cough, increasing the appetite, removing the fever, increasing the strength, and almost suppressing night sweats, while it gives an *embonpoint* such as the patient had only in his healthy days. The abnormal noise heard in the breast of the consumptive ceases, and is replaced by a healthy respiration, or at least is smoother in sound, owing to the cicatrization of the diseased pulmonary tissue. The improvement in condition may continue for months, provided that the cure is not interrupted too soon. These physicians observed that the symptoms of the disease recur as soon as the use of the creosote is neglected, in the opinion that the lungs are healed.

From these statements it will be seen that Camboulives and many others did not believe in this beneficent action of creosote. They used it without obtaining the desired results. But creosote is a medicament that comes into the market of various degrees of quality, and if the apothecary does not dispense the genuine beechwood tar creosote —*Kreosotum faginum*—the expected results cannot be had.

To ascertain how justified was this unequalled action of creosote, I made use of it in several cases, and I found that consumptives and sufferers from chronic catarrh visibly improved, and in one instance its use had to be stopped because the *embonpoint* of the patient, who had lost flesh considerably, had so increased that new and large clothes had to be obtained. The results obtained by Bouchard and Gimbert have been fully confirmed by my experience, but, of course, only where genuine creosote is employed.

Among the curative qualities of creosote must also be reckoned its anti-asthmatic action. A railway employe, who suffered from *asthma spasticum*, and who derived some relief from the usual remedies without getting rid of the attacks, had only two attacks after taking the creosote pills. These, however, were mild, and they then ceased altogether. As a precautionary measure, however, he continues to take the pills every other day.

As creosote made from beech tar is one of the grandest remedies for keeping up consumptives and those suffering from bronchial diseases, for increasing the flesh of the emaciated, removing asthma, and perhaps bringing tuberculosis to a standstill in its early stages, as well as relieving kidney diseases and destroying the vitality of intestinal worms, it is the incumbent duty of the apothecary to dispense only the genuine and to convince himself of its quality. We shall explain the marks of genuine creosote and the sources from which it can be had.

In a case before me are phenols and creosotes, as follows:

1. Colourless Kreosotum.
2. Colourless Kreosotum album verum.
3. Yellow Kreosotum Anglicum.
4. Brownish Yellow Kreosotum Faginum.
5. Chemically pure Ph. G. Kreosotum from beechwood tar (Kreosot Hannoveranum) yellowish.
6. Kreosotum Saginum (A) yellow.
7. ,, ,, (B) yellow.
8. ,, ,, (C) brown.

Out of these eight kinds only Nos. 4 and 5 proved to be genuine; No. 8 was genuine, but very dirty.

1. Pure creosote made from beechwood tar is insoluble in double its volume of anhydrous glycerin, while other creosotes are completely soluble, or give a perfectly limpid mixture. When the mixture is milky, or whitish, with double the volume of anhydrous glycerin, the creosote is presumably pure, but if coloured (No. 8 was of a muddy red), then the creosote is not genuine.

Phenol is not an adulterating agent in every case; there are others which are not soluble in glycerin, and least of all in a solution of 75 per cent of glycerin (as, for instance, creosol or creosyl-alcohol).

Nos. 1, 2, 3, 6, and 7, when mixed with a double volume of anhydrous glycerin, gave clear liquids. Mixtures of a quarter to one-third of creosote and three-quarters to two-thirds of phenol with glycerin under the same conditions give clear liquids.

2. To observe the action of the phenol, we mix three volumes of glycerin (75 per cent) with one volume of the suspected creosote, and shake well. Two layers will be formed when the mixture settles; one will be very muddy; the other somewhat less so.

The volume by which the last layer has been decreased is approximately that of the phenol present; in order to ascertain it definitely, we must increase the layer of the 75 per cent glycerin by an equal quantity of the same glycerin, and shake the whole well. The phenol passes into the glycerin up to 98 per cent; or we can shake up the creosote with 5 per cent of caustic ammonia, which dissolves phenol but not creosote from beech tar.

Graetzel and the writer both observed that creosote when agitated with glycerin almost doubled its volume. But, with an undoubtedly genuine specimen before us, we cannot obtain this increase of volume, and this change cannot therefore be regarded as an indispensable mark of beech tar creosote.

These two tests (1 and 2) with anhydrous and 75 per cent glycerin indicate whether we have genuine creosote, but two reactions are yet required to fully prove it.

3. Equal volumes of creosote and soda lye (of 1·334 specific gravity) are mixed together to ascertain the wood tar particles. With a very slight degree of heat development there is a clear yellow solution. If the mixture is not clear and transparent, or has another colour, or when it stiffens to a non-liquid mass, the creosote is not pure, if it be present at all. No. 1 gave a muddy whitish, and No. 8 a greyish brown mixture, which thickened after the lapse of half an hour. The remaining non-creosote specimens gave light lemon, dark lemon, or brownish yellow mixtures. No. 4 gave a red mixture, and contained 9 per cent of non-creosote matters.

The new German Pharmacopœia gives a variation of this lye reaction. The soda lye of 460 specific gravity and creosote mixed by equal parts of weight should give a clear liquid (it may be yellow), but must not be dark coloured or throw off bad-smelling tar when diluted with water. According to this test, three kinds of non-creosotes, Nos. 1, 2, and 3, genuine creosotes, and only No. 8 gave a dark coloured muddy mixture. Testing with a soda lye of 1·334 specific gravity is therefore to be preferred.

4. Beech tar creosote gives a clear solution in petroleum benzine. A mixture of 1 vol. creosote and 2 vols. of benzine is almost colourless or yellowish, but perfectly clear. Neither phenol nor creosol is soluble in benzine, and creosote gives a rather muddy mixture with even 5 per cent of this phenol, which, after settling an hour, separates into two layers. This benzine solution, when transparent, is divided into three portions. The first is decomposed by an equal volume of caustic ammonia; the second by a lye of caustic soda of 1·160 specific gravity, and both parts are well shaken. No dark colouring, dark brown, or crimson should show itself in the course of half an hour. The third portion is (according to Hartmann and Hauers) mixed and shaken up with an equal volume of caustic baryta water. In this case neither blue, violet, nor red colour should appear. It is immaterial in what layer, the aqueous or the oily, the colouration is; they indicate tar components which should not be present.

5. Mix 1 vol. of creosote and 2 vols. of a 15 to 18 per cent caustic ammonia, shake well, and put aside. The genuine clear creosote will, in the course of half an hour, be coloured almost a lemon shade, and an aqueous layer on top will be yellow, grey, or some pale colour. A dark colour indicates foreign bodies, and if the volume of the creosote has diminished, it contains phenol, creosol, or kindred matters that do not belong, however, to creosote. The test can be made with even a 10 per cent caustic ammonia, but a double volume is then requisite.

6. Equal volumes of collodion and creosote should not form into a jelly, but should rather become a liquid mass after half an hour; in the contrary case more or less phenol is present.

The first three or five tests are sufficient for true creosote, so that the other reactions may be dispensed with.

A creosote that does not comport itself as such should not be used, at least inwardly. Some of the kinds may be admitted for external veterinary use, but must not be classed as genuine.

Doses should be as small as possible, but often repeated. Proper doses for an adult are 0·02 to 0·03 and 0·04 two or three times daily. The maximum single dose is 0·05, and the maximum for a day 0·2. The pilulæ Kreosotatæ contain 0·0167 g. in each pill (*Ph. Centralh.*, 1881). Consumptives in the last stage may take two or three of these pills two or three times a day, according to bodily size, and if they feel tolerably well after some days' use they should take two or three pills uninterruptedly night and morning, dropping them, perhaps, one or two days a week.

Pure creosote is pale yellowish, exudes oil, and is of 1·06 specific gravity. The gravity should be fixed at 1·050 to 1·080, as the lighter creosotes were either impure or not properly such.

Creosote is best administered in pills. The pilular mass is made by melting together 2 parts of yellow wax and 1 part of creosote, to which other suitable ingredients are added in form of powder, as quinine salts, salicylic acid, bals. solution, rad. gent., &c. Any addition of ether or spirits of wine to give consistency to the mass should be avoided, and is not necessary.

AERIAL NAVIGATION.

By F. Barnett.

Utility.—To be of any great utility it must be superior to terrestrial navigation. It must either transport greater weights at an equal epeed or equal weights with a greater speed, or where one factor is less the other must be correspondingly greater to make a product that is superior to all other kinds of navigation.

Perhaps the greater utility would be in speed. A great deal of the heavy commerce as carried on to-day is done in a reasonably short time; but the speed with which the lighter traffic is carried, such as people, mail, and express matter, could be very profitably increased.

But suppose we find a capability in aërial nagivation of carrying great weights with greater facility and speed than is now known, it also would be of great benefit to humanity. The natural products of different climes could be exchanged with much less labour and expense.

The simple balloon is unreliable. The balloon with propellers is necessarily so large as to offer such a resistance to the air as to retard its velocity very much. It cannot acquire any great momentum, and momentum is a storage of power. But even if such a balloon with propellers did acquire a velocity of ten miles an hour, it would be of little use except to the pleasure seeker.

The ideal air-ship would have a speed of from sixty to a hundred miles an hour, and carry quite a number of passengers and freight. Its course must be certain and its voyages always end safely. Therefore, in constructing an ideal machine, we must consider its *weight*, *velocity*, *momentum*, and *form*.

Weight.—Weight is absolutely necessary to horizontal flight, and not only so but contributes to it. Without weight, no momentum could be acquired, and momentum is an accumulation or storage of power or energy. Weight is easily moved in a horizontal direction by a slight but constant force, but not easily or suddenly changed about by the wind like a lighter body.

If the resistance to horizontal motion be one pound per second and the momentum ten pounds per second, then, if the live force be suspended, it will take ten seconds before the power of momentum is used up. But in a balloon the resistance is equal or perhaps exceeds the momentum, and the horizontal motion depends entirely upon the live force. This power of momentum can be changed to an upward force or power. A momentum of ten pounds would lift the body one foot high in one second.

Momentum is a storage of energy. A bird in flapping its wings expends a certain amount of energy in the down stroke. Then to make the up stroke, it must not only counteract the momentum of the wing acquired in the down stroke but use the same amount of energy to make the up stroke as it did the down stroke. The momentum acquired in the down stroke is not only lost, but must be neutralized by the same amount of energy. The momentum acquired by one revolution of a screw propeller is not counteracted but helps the original force.

Velocity—Is one of the factors of momentum.

If the propelling power, which we will assume is constant and acts in a horizontal direction, is any in excess of the resistance, then, no matter how slow the initial velocity, the body will ultimately acquire an accelerated velocity which would be very considerable, or so great that the resistance of the air alone would be equal, and then the body would assume a uniform velocity. It is from this very reason that the balloon cannot be propelled with any great speed. The resistance, which increases as the square of the velocity, too soon becomes equal to the propelling power.

Thus: If the propelling power be 90, and the resistance at the rate of one foot per second be 10, then the resistance at three feet per second would be equal to the power.

Momentum—Is a storage of power.

If the resistance to horizontal motion be one pound per second, and the momentum ten pounds per second, then it will take ten seconds before the power of momentum is exhausted. A body in falling stores up enough power to carry it to the same height less friction; or to lift ten times its weight one-tenth as high. This power is in the momentum, and does not depend upon an outside force. No force is ever lost; it is simply converted into different forms or results. The force of momentum, if utilized, can be changed to a lifting force. That is, the direction of the force of momentum is changed.

The advantages of momentum in horizontal motion would be great. If the propelling power were suddenly stopped, it would carry the machine quite a distance, or at its then acquired speed less the friction of the air. All excess of propelling power over the resistance of the air would result in an accelerated velocity, or an accumulation of power or energy; while a body that has no weight can acquire no momentum and consequently no acceleration of velocity.

The Advantages of Momentum in Screw Propellers over Wings.—The momentum acquired in the down stroke is not only lost but must be neutralized before the up stroke can be made by the same amount of force in the opposite direction. In addition to this, the same amount of force must be used to make the up stroke as was used to make the down stroke. There was sufficient momentum acquired in the down stroke to make the up stroke if it could have been properly utilized.

An Automatic Gas Closer.—H. Michaelis has invented an apparatus for turning off a current of gas at any required time. The principle is that of an alarum clock.

The Scientific Review

AND

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SESSION 1882—1883.

June 7th.—Conference on Patent Laws. The Government Bill will be considered.

T. Morgan, Sec.

Subscriptions are payable to Mr. G. A. Stretton, the Receiver, 4, St. Martin's-place, S.W., who is the proper official to give receipts.

Proceedings of the Institute.

May 10th.—A Paper was read by Mr. T. Morgan on "Improvements in Valves." A full report will be found in another page.

May 24th.—The Annual General Meeting was held, Admiral Selwyn occupying the chair. The Report (see page 68) was read and adopted, as was also the Balance Sheet, and the Council and Officers were elected.

Monthly Notices.

Biological study is being pursued at Cambridge University to an extent astonishing to those who look back to the time when, only a few years ago, three students were placed in the Natural Sciences Tripos. In the last two winter terms over one hundred and thirty students attended Dr. Foster's courses of elementary and advanced physiology and did the practical work in connection with them. The lectures and classes in animal morphology which the late Prof. Balfour commenced, and which have been continued by Mr. Adam Sedgwick with able assistance, have not fallen off; over ninety pupils were attending in the Lent term of this year. Botany, the latest of these subjects to be revived at Cambridge, has already this year, under Dr. Vines's care, attracted nearly forty students to go through practical courses in vegetable anatomy and physiology; and research in botany is evidently advancing, for three original papers are to be read next Monday before the Cambridge Philosophical Society by past or present students at Cambridge.

Dr. Bernard J. Harrington, Professor of Mining in McGill University, has published a "Life of Sir William E. Logan, LL.D., F.R.S.," the first Director of the Geological Survey of Canada.

MM. S. Wroblewski and K. Olszewski announced to the Academie des Sciences on the 23rd of April the complete liquefaction of nitrogen. Nitrogen cooled in a glass tube −136°, and submitted to a pressure of 150 atmospheres, remained gaseous—nothing could be seen in the tube. If the gas is allowed to escape slowly, and the pressure is not allowed to fall beyond fifty atmospheres, the nitrogen is completely liquefied, presenting a very distinct meniscus, and evaporating rapidly.

Prof. H. Gorceix, of the Ouro Preto School of Mines in Brazil, in the *Annals* just issued, gives a valuable memoir on the mineralogical and chemical character of the metamorphic rocks of Minas Geraes. Mr. A. Bovet adds a contribution on the mineral industry of that province, dealing chiefly with gold and iron.

Distillation in a Vacuum.—H. Schüller has observed the behaviour of 13 inorganic and 12 organic bodies when heated in a vacuum, their sublimations and distillations, and the nature of the residues. Many of the elements examined, especially selenium, tellurium, cadmium, zinc, magnesium, arsenic, and antimony, were capable of sublimation, while the very fusible metals, bismuth, lead, and tin, distilled with difficulty, the last-mentioned scarcely at a red heat. On the other hand, Demarçay found bismuth volatile at 292°, lead and tin at 360°, which Schüller explains by the presence of volatile impurities. During the whole time of the distillation of a metal an escape of gas was observed. But on repeated evaporation this phenomenon was imperceptible, or very slight. Sodium, selenium, tellurium, cadmium, zinc, arsenic, and antimony evaporate so readily in a vacuum that this method may be used for their purification. Amongst organic bodies many unstable mixtures, such as tallow, wax, and resin, distil so easily in a vacuum that they may thus be separated from impurities.

Mr. J. Tebbutt has communicated to the *Astronomische Nachrichten* (No. 2513) a second series of observations of the great comet of last year (II., 1882), made by him with his 4½-inch equatorial at Windsor, New South Wales, and extending from the 1st of December to the 2nd of March. "After the close of November," he says, under date March 3rd, "the comet ceased to have a nucleus. During the months of December and January it presented the appearance of an ill-defined and rather oval nebulosity slightly condensed towards the centre, but during February its oval form was not so well marked. All the positions now given refer to the centre of this nebulous patch. The comet was just visible to the unassisted eye as late as February 13th, but it is now excessively faint even in the telescope, and no further observations of any value can be obtained." We have already mentioned that it was seen in Europe, although very faint, until about a month later than the above date. Baron von Engelhardt's last observation at Dresden was made on the 5th of April (the day before that of Prof. Riccò at Palermo); the comet was then perceptible with difficulty, a bright little point ("ein helles Pünktchen") being all that could be seen.—*Athenæum.*

THE SCIENTIFIC REVIEW
AND
Scientific and Literary Review
INCORPORATING THE "JOURNAL OF THE INVENTORS' INSTITUTE."

JUNE, 1883.

SAHARA.

Perhaps the most daring of modern engineering projects is that proposed by M. de Lesseps in 1877, and which is now occupying serious public attention, for inundating the Great Desert of Sahara with the waters of the Mediterranean, and thus converting that vast sandy waste into an inland sea. The very boldness and grandeur of this idea has no doubt won over the sympathies at least of the general public, and also, to some extent, of the engineering profession, all over the world; notwithstanding the enormous outlay the scheme would involve, and the army of 100,000 workmen required for its accomplishment.

At last, however, we have some serious objections to the project, coming from the pen of an American, a source from which we usually least of all expect to find any "blocking" of gigantic enterprises.

Mr. R. W. Wright, in a New Hampshire paper, has put forward a number of reasons why this great work should not be attempted, which will doubtless be accepted as valid by a great many persons who may be interested in the future of the North of Africa. Chief amongst these reasons we select the following—

1. The existing desert is "a great radiator of heat, many times greater, in fact, than the Gulf Stream." It operates, like that oceanic current, to force the "thermal equator" northward, and to change it as proposed would affect the mean temperature of all Europe, and might seriously modify its area of civilization.

2. The desert acts "as a great aërial sponge," absorbing atmospheric moisture over a wide and rainless region, and thus ameliorating the climate of a large portion of the Eastern hemisphere.

3. This vast sand plain acts as a "storm barrier," arresting and breaking up the tornadoes on their way from the tropics to devastate Europe. It is a mistake to suppose these destructive winds to be generated amid the solitudes of the desert. The cause of the simoom, which often takes on the alarming form of a huge sand-spout, is the fact that when a tornado strikes the desert it begins at once to lap up the particles of sand, until it has thus gathered into itself thousands of tons, which finally load it down beyond its carrying power, and it falls with its burden and finds its fury spent.

4. The sands of Sahara act as a great "absorbent of malaria," thus preventing the fatal maladies of Africa from invading Europe. The desert is known to be absolutely free from malaria, for the good reason that it contains nothing to produce it. The equatorial regions south of the desert breed the most dreadful diseases known on the globe. Substitute an inland sea for the waste of sand, and the pestilential winds would sweep more swiftly across to precipitate their plague-germs on the population of Europe.

5. Mr. Wright's greatest objection to the project is that it would create a "dead sea," similar to that of Palestine, only on a far larger scale. There would be an artificial inlet, but no outlet. The waters would be hopelessly stagnant, receiving no fresh-water streams from the African watershed, and out of the way of the oceanic currents. The Tunisian canal would let in the salt water from the Mediterranean, which would become more and more briny by constant evaporation, increased further by the extensive natural deposits of salt already known to exist in portions of the desert. The inevitable result would be the creation of a lifeless, terrible waste of dead waters, environed by dreary salt hills and dismal marshes like those that now surround the site of ancient Sodom.

Now, without desiring to detract from the ingenuity of Mr. Wright's objections, we shall venture to state our conviction that his conclusions are not, in every case, correct.

1. Taking the desert as a "radiator," we fail to see why the "thermal equator" should not be pushed northward as well, by means of water, in the heart of Africa, as in the Atlantic Ocean, through the medium of the Gulf Stream.

2. If it is such a benefit to this rainless region, for water merely to be absorbed by the desert sands, surely it would be a far greater benefit to those parts for water to be conveyed there in large volume.

3. Accepting the desert as a "storm barrier," it can only be so to the extent of its resistance to the force of the wind; and we think this is clearly less than with an equal expanse of water, the surface of which the simoom could lash into furious waves, and thus expend its force.

4. Whatever may be said in favour of the desert as an absorbent of malarial germs, experience certainly teaches us that the salt sea cuts off all contamination from this cause. It is only necessary to mention the numerous cases in tropical countries, where a convenient sanitarium is found on some island at a comparatively short distance from the mainland.

5. We certainly admit that one of the objections under this head, namely, the probable large deposit of salt, may have some degree of validity; but the idea of a sheet of water which might possibly extend for 3000 miles in length by 800 miles in breadth, and swept occasionally by such winds as the simoon, becoming "hopelessly stagnant," does indeed pass beyond our comprehension We think, further, that it is highly probable that rain would be brought in such quantities to the surrounding higher lands as would create fresh water-courses to the inland sea, and these might to a large extent compensate the specially local evaporation, thus preventing in a great measure the deposition of salt supposed.

Altogether, we do not see that these clever objections, although usefully put forward, need discourage the deservedly great French engineer who so successfully cut the Isthmus of Suez in the face of prognostications of far worse evil omen than any which are now brought forward against his last and greatest projected engineering enterprise.

W. G.

INVENTORS' INSTITUTE.

The Annual Meeting of the Inventors' Institute was held on May 24th at 4, St. Martin's Place, Trafalgar Square. The chair was taken by Admiral **Selwyn**. Amongst the Members present were Messrs. Greenfield. McLauchlan, Stretton, F. H. Varley, and T. Morgan, Secretary.

The minutes of the preceding meeting were read and confirmed.

It was proposed by Mr. Greenfield, seconded by Mr. Stretton, and carried unanimously,—"That the Executive Council and Officers be and are hereby re-elected."

It was proposed by Mr. Stretton, seconded by Mr. Greenfield, and carried unanimously, —"That the retiring member, Mr. F. Ransome, be re-elected, and that Messrs. Braby and N. Wilson be elected as members of the Executive Council in place of Messrs. Campin and Paterson, deceased."

It was proposed by Admiral Selwyn, seconded by Mr. McLauchlan, and carried unanimously,—"That the Balance-Sheet presented to the Council be and is hereby approved and adopted."

It was proposed by Admiral Selwyn, seconded by Mr. Greenfield, and carried unanimously,—"That the thanks of the Institute be given to the Council and Officers and to the readers of Papers before the Institute during the past year.

The meeting concluded with a cordial vote of thanks to the Chairman, Admiral Selwyn proposed by Mr. McLauchlan and seconded by Mr. Greenfield.

21st Annual Report of the Council.

During the past year the Institute has sustained a great loss by the death of its Secretary, F. W. Campin, Esq., who from almost the foundation of the Institute has been a member of the Council, and on the decease of R. Marsden Latham, Esq., in 1873, succeeded to the office of Secretary, which he held to the day of his death, which took place on Sunday, April 1st. He may be said to have laboured all his life for the benefit of Inventors, and it is a matter of regret that he did not live to see what was his wish, the simplifying of the Patent system, and more particularly the reduction of the fees, which after years of agitation has at last been to a certain extent conceded by the Government Patent Bill. His death necessarily left the Secretaryship vacant, and this, *pro tem.*, was taken by Mr. T. Morgan, and he asks the indulgence of the members should the Report about to be given be not of that comprehensive character it would have assumed had Mr. Campin been still alive. The first point to which attention is drawn is that relating to the Patent Laws.

The Bills introduced during the last Session of Parliament, as members are aware were not passed. These were, (1) that introduced on behalf of the Society of Arts by Sir John Lubbock, and (2) that by Messrs. Anderson, Broadhurst, and Brown.

It is unnecessay to give details of these Bills, since they have been discussed at various meetings, and are well-known as to their character and the advantages or disadvantages they offer. During the present Session of Parliament these Bills, with slight modifications, have been again introduced and the Government has also introduced a Bill which has passed the second reading, and now awaits consideration of the Grand Committee to whom it is referred. This Bill, we are informed, will no doubt pass this Session, It undoubtedly gives in the first instance great advantages over the present Act, seeing that a Patent can be obtained for £4, as against £25 now charged by the Government. There is, however, a great deal to remark upon in these Bills as regards the fees; Inventors by the Government Bill to keep their Patents in force being obliged to pay £50 and £100 stamp duties as under the present Law, the only comfort to Inventors being that the £50 is payable at the fourth year instead of at the third as at present.

Although the subject of the Patent Laws has largely absorbed the attention of the Institute, papers read at the ordinary meetings have been generally well attended, and discussions thereon have elicited criticisms which were of great value.

Papers have been read, amongst others, on recent improvements in the electric light, also on valves, referring to some recent improvements.

With regard to the Finances, the Executive Council submit the usual balance sheet prepared by the Acting Treasurer, and audited by Mr. J. P. Cutts, showing a favourable balance. During the past year the Institute has lost by death several of its old members; amongst those on the Council the well-known Thomas Aveling, Esq., (of the firm of Aveling and Porter), T. Paterson, Esq., and as before mentioned, F. W. Campin, Esq. A special meeting was called for April 4th, when a deputation was appointed to attend the funeral of the Secretary.

Owing to the decease of Messrs. Paterson and Campin two vacancies occur on the Executive Council. The retiring member in rota is F. Ransome, Esq., eligible for reelection.

It is suggested that Newton Wilson, Esq., and T. Braby, Esq., be elected to fill the other two vacancies.

A Source of Error in Polarisation.—Coloured liquids give discrepant rotations, both by day-light and lamp light. The influence of colour is insignificant if the monochromatic soda-light is used.

Determination of Melting-points.—Guichard melts the substance in question, sucks it into a capillary tube open at both ends and slightly widened at top up to the middle, and allows it to congeal. The space above is then filled with a coloured liquid which does not attack the substance, and the little tube is heated along with the thermometer in the usual manner. At the moment of melting, the coloured fluid runs off, and the temperature is read off. It is questionable whether, in many cases, the efflux may not be hindered by capillarity.

Cork Shavings for Vinegar.—The wood shavings commonly employed in vinegar factories preserve their activity for a certain length of time, and then become useless. Bersch explains this on the supposition that the shavings becoming saturated with liquid, get heavier, and press down on those beneath so hard as to prevent the air from circulating through them. He therefore recommends the substitution of the waste cork from which stoppers, &c., have been cut, for the wood chips. The elasticity of the cork is increased by moisture, so that they cannot pack together even in the tallest tanks. Small organisms exist in the pores of the cork, and among these many vinegar bacteria, so that the cork is very active in making vinegar.

Importance of Small Industries.—Speaking recently in Congress of the need of encouraging certain relatively small industries Senator, Miller referred to the city of New York, the greatest manufacturing city in America—he might have said in the world —and "yet she has not a cotton mill, a blast furnace, or a rolling-mill within her borders. Her manufactories are small," he said, "but they employ more than a quarter of a million people." It is worthy of notice in this connection that while recent patents have much to do with the means and methods of the great staple industries, such as steel and iron production, iron milling, cotton and woollen manufacture and the like, the smaller, yet in the aggregate immensely important, industries are almost wholly based upon and due to the development of recently patented inventions.

Proceedings of Societies.

GEOGRAPHICAL SOCIETY.

April 23.—The Right Hon. Lord Aberdare, President, in the chair.—The following gentlemen were elected Fellows: Major W. G. R. Herd, Rev. F. A. Saville, Messrs. J. M. Barbour, A. H. S. Barry, H. G. Erichson, F. G. Gunnis, T. H. Lees, E. L. Mitford, C. G. Nottage, A. Roebuck, W. S. Routledge, T. Saunders, and J. M. Stewart. —The paper read was "China in its Physical and Social Aspects," by Mr. E. C. Baber (Chinese Secretary to H.M.'s Legation, Pekin).

METEOROLOGICAL SOCIETY.

April 18.—Mr. J. K. Laughton, President, in the chair.—Prof. H. Robinson, Dr. W. Doberck, Meesrs. T. G. Bowick, E. C. Clifton, H. Culley, R. N. Pearson, and J. E. Worth, were elected Fellows.—The following papers were read:—"On Cirrus and Cirro-Cumulus," by the Hon. F. A. R. Russell.—"Some Notes on Waterspouts, Occurrence and Formation," by Mr. G. Attwood. The paper contained an account of several water-spouts observed in the Pacific Ocean, and also of one seen in the Atlantic Ocean. The author believes that the waterspouts in the Pacific Ocean were caused by a cloud heavily charged with cooled moisture, drifting from the high mountains of Costa Rica, coming into contact with air-currents and clouds travelling in a different direction, and of a warmer temperature, by which contact the cloud heavily charged with moisture was given a rotatory motion, causing it to discharge part of its moisture, and assume a cylindrical figure and fall down by its own gravity.—"Records of Bright Sunshine," by Mr. W. W. Rundell. This is a disscussion of the sunshine records made in the United Kingdom during the years 1881 and 1882, from which it appears that there is more bright sunshine upon the coast than there is inland.—"Note on Wind, Cloudiness, and Halos; also on Results from a Redier's Barograph," by Mr. E. T. Dowson.—"On the Cold Weather of March, 1883," by Mr. W. Marriott.

PHILOLOGICAL SOCIETY.

April 20.—Dr. Murray, President, in the chair.—The American Philological Association having agreed to adopt the Society's proposals for a reformed spelling if the Society would waive a few points, it was unanimously resolved to waive these points, in order that the two bodies might agree on one and the same scheme. The paper, read by Mr. H. Jenner, was "On the Decay of Language, as illustrated by the Cornish Language," by the Rev. W. S. Lach-Szyrma. Seven stages of the decay of Cornish were distinguished and commented on, and a list of extant Cornish terms in mining, fishing trade, and home life was given. Even if these words died out under the influence of Board school teachers, &c., the Cornish names of men and places would no doubt last as long as the land itself.

THE INSTITUTION OF CIVIL ENGINEERS.

April 19.—the fifth of the series of six lectures on the application of electricity, "Electricity applied to Explosive Purposes," was delivered by Sir F. A. Abel.

April 24.—Mr. Brunlees, President, in the chair.—The paper read was "Resistance on Railway Curves as an Element of Danger," by Mr, J. Mackenzie.

HISTORICAL SOCIETY.

April 19.—Lord Aberdare in the chair. —Messrs. A. A. Donnay, E. C. Lings, and J. M. Russell were elected Fellows.—Sir R. Temple read a paper "On Political Lessons of Early Chinese History." He began by calling attention to certain salient points in the political and strategic geography of China, and then gave a description of China before the Mongol conquest, 1200 A.D. Originally the Chinese lived under a feudal system. The country consisted of seven states, each under a local lord, but federated under an emperor, who represented merely the headship of a feudal confederation. This system was destroyed 200 B.C. by the "Chinese Cæsar," and replaced by a real empire, which lasted for centuries. Many administrative achievements of the empire seem at first sight to anticipate parts of our modern civilization, but a closer examination reveals defects fatal to national progress and political stability. The author next gave a graphic account of the Mongol conquest and of the gallant resistance in Northern China, which, after a resistance of twenty years, was overcome only when the invaders had the aid of the Sungs of Southern China, who lent their help on condition that they should share the spoil. The usual quarrel ensued over the spoil, and then followed "the most illustrious chapter in the record of Chinese patriotism," the long-sustained struggle of the Sungs, both by sea and land. A rapid review of Chinese history to the end of the eighteenth century brought the paper to a close.—Sir T. Wade afterwards made some remarks. He said that there was an almost standing error about the population of China, due to the single-storied houses and the narrow streets of the towns, which give the traveller an exaggerated idea of the number of inhabitants. After a few words on the theocratic sanction of the government, he pointed out that the difficulty about the Chinese army was due not to the want of courage in the soldiers, but to the difficulty of getting educated men, who despise all exercise, as officers.

PHYSICAL SOCIETY.

APRIL 14.—Prof. C. Foster in the chair.—Mr. W. F. Smith and Mr. G. Forbes were elected Members.—Mr. W. L. Carpenter read a paper "On the Science Teaching in the Board Schools of Birmingham and Liverpool," and advocated the system of skilled lecturers going from school to school in a district.—Mr. Glazebrook read a paper "On Curved Diffraction Gratings and a New Polarizing Prism."—The Secretary read a paper, by Messrs. Stokes and Wilson, "On Experiments on the Viscosity of Saponine Water."

ON THE DIAMOND FIELDS AND MINES OF SOUTH AFRICA.

At a meeting of the Institution of Civil Engineers on the 8th of April, Mr. Brunlees, President, in the chair, a paper was read on the above subject.

The author commenced by stating that Kimberley was situated in Griqualand West, about 700 miles north-east from Table Bay, and 450 miles inland from Port Elizabeth and Natal on the East Coast. Lines of railway were in course of construction from Table Bay and Port Elizabeth to Kimberley, and were about half completed. In Griqualand there were several diamond mines, the principal of which were Kimberley, De Beer's, Du Toit's Pan and Bultfontein.

In the Orange Free States there were also two mines, viz., Jagersfontein and Koffeyfontein, the first of which produced fine white stones. The mines were all divided into claims, the greatest number of which were to be found in the Du Toit's Pan mine. Bultfontein came next.

The deepest and most regularly worked was the Kimberley mine. The next deepest was De Beer's, which, however, was very unevenly worked. Then followed Du Toit's Pan and Bultfontein Du Toit's Pan mine ranked next in importance to Kimberley mine. Diamonds were first discovered in 1867 by Mr. O'Reilly, a trader and hunter, who visited a colonist named Van Niekirk, residing in Griqua. The first diamond, on being sent to the authorities, was valued at £500. Considerable excitement was caused throughout the Colony, and the natives commenced to look for diamonds and many were found, among which was one of 83½ carats, valued at £15,000. In 1868, many enterprising colonists made their way up the Vaal River, and were successful in finding a good number of diamonds. The centre of the river-diggings on the Transvaal side was Klipdrift, and on the opposite side Pniel. In all there were fourteen river-diggings. Du Toit's Pan and Bultfontein mines were discovered in 1870 at a distance of 24 miles from the river-diggings. The diggers took possession of these places. Licences were granted giving the first diggers a right to work. In 1871, De Beer's and Kimberley mines were discovered, and in 1872 Mr. Spalding's great diamond of 282½ carats was found at the river-diggings.

The mines were of irregular shape, and were surrounded by reef. The top reef was a loose shale and had given great trouble from the frequent slips. Below this were strata of trachytic breccia and augite; the formation was then seamy to an unknown depth.

Within the reef the surface soil was red, and of a sandy nature. The next stratum was of a loose yellow gravelly lime, and the third blue, of a hard slatey nature. This last was the real diamantiferous soil. Large stones had been found in the "yellow," but the working of this generally did not pay. Kimberley mine, however, had paid very well all through. The method of working in deep ground was determined by roadways running north and south. The soil was hauled up to these roadways and taken to the sorting-tables. The roadways decaying shortly after exposure to the atmosphere, a system of hand windlass was adopted, which worked very well for a time until horsewhims were introduced in 1873. The depth of the mines increasing, horsewhims had to give way to steam-engines in 1876.

The first diggers treated on an average 10 loads per day each party. At the present time the least taken out by any engine when fully employed was 250 loads per day. The cost of working with present appliances the first 100 feet in depth, was 3s. 6d. per load; the second 100 feet (mostly blue) 5s.; the third 100 feet 8s., and the fourth 100 feet 11s. Through scarcity of water a system of dry-sorting had to be resorted to for several years; but it was superseded by the introduction of washing-machinery, which was now generally employed.

At the commencement, through inexperience, many serious mistakes were made. When the first diggers reached the bottom of the red sand, they thought no diamonds would be found in the next stratum. When, however, diamonds were found in the second stratum, the diggers had again to remove the *debris*, and so also when the "blue" was reached. Some of the claims in the Du Toit's Pan and Bultfontein mines were irregular in shape. The other mines, however, had been properly and regularly laid out. One or two shafts had been sunk and connected with the mines by underground galleries. These galleries were convenient in the case of falls of reef. Labour at first was cheap; but from 20s. per month, wages rose to 30s. per week, and food. The yellow soil offered no difficulty in working, being loose and broken, but the blue soil required blasting.

Several methods were adopted for extracting the soil and carrying it from the mine before steam was introduced. The cost of wood for heating purposes was a serious item, but good coal had now been found at 160 miles from Kimberley, costing £13 per ton; another serious item of expense was the transport over natural roads only, costing from £18 to £30 per ton.

The machinery designed by the author for this industry was described. A 16 H.-P. direct-acting winding-engine was introduced for hauling up loads at the rate of about 1,000 feet per minute; and a 25 H.-P. geared-engine, for hauling up heavier loads, at the rate of from 600 to 700 feet per minute.

Water was dear and water-heaters were fitted to each engine, by which 33 per cent. of the water was again used, thus saving one-third. The boilers were of the locomotive type, mostly of steel, to save weight, and thus reduce the cost of transit. The fire-boxes were also made of steel of very soft and ductile quality. A semi-portable engine was made for driving the wash-mill. The engine was so arranged that it might be removed from the boiler and placed separately. The boiler was made to work at a pressure of 140 lbs. per square inch. Automatic cut-off gear was fixed to each engine, and the governors were provided with a spiral spring for adjusting the speed. A screen or cylinder wash-mill and elevator were used for dealing with the diamantiferous soil, and were described. Standing wires were fixed at the back of the machinery, and passed over a frame fixed at the top of the mine, the end in the mine being secured to strong wooden posts. After the blue soil had been blasted and collected into trucks it was placed in tubs which ascended the standing wires. It was then emptied into the depositing-box. The yellow soil might be put into the wash-mill direct, also that portion of the blue which had passed through the screen fixed over the depositing-box. The remainder of the blue which was spread out to a thickness of 4 or 6 inches on the depositing-ground some distance from the mine to dry was delivered into the upper part of the screen. The return-water from the elevator with a portion of fresh water, was also discharged at this point, and operations were thus greatly facilitated, the soil becoming thoroughly saturated, and passing more easily down the shoots. The large pieces which would not drop through the meshes of the screen were discharged into trucks at the lower end and carried away. The smaller pieces with water in the form of sludge, fell through into a shoot, and thence were conveyed into the wash-mill pan, and there kept in constant rotating motion by agitators. The diamonds and other pieces of high specific gravity sank to the deepest part of the pan, and the remainder of the sludge was forced over the inner ledge to the elevator. The sludge was then lifted and thrown upon an inclined screen and down the shoot over the side of the bank. The residue left in the pan at the end of the day's work was passed through a pulsator, in which, by the force of water the mud and lighter particles were carried away, leaving behind the diamonds, agates, garnets, and other heavy stones. It was the practice occasionally to put a few inferior stones in the soil, to test the efficiency of the machinery.

In 1881 the author paid a visit to Kimberley, and found the industry a large one. The Post-office return showed the value of diamonds passed through the office in one year to be £3,685,000. Illicit diamond traffic had hitherto been a source of great trouble at the Fields. It was a question whether this industry would ever cease; in any case there was no doubt but that it would last for over a century. It was believed that the main bed of diamonds had not yet been reached, and that the mines in operation were merely shafts leading to it. Now that the waterworks were finished with a bountiful supply of water, coupled with the great boon of railways to the Fields, and the advantage of a law recently passed for the prevention of illicit buying, a great and prosperous future was in store for the Diamond Fields.

MATTER AND FORCE.

THE ways in which this subject of matter and force may be, and have been considered, are exceedingly numerous, and many of them are very misleading, not to say mischievous in their results.

We believe that the principal cause of the thraldom in which philosophic thought thereon has been held in the past, is mainly to be found in the manner of approaching the subject, which being followed for ages, became to be looked upon as a necessary factor in any investigation of this vast problem. The result of this method is at once apparent in the expression "matter *and* force," as understood by the vast majority of even thinking mankind, which to them involves two separate entities, and have become to be regarded as existences *apart*, which may or may not, according to circumstances, be brought to operate upon each other.

Now it may be quite true that as a mental operation merely, we may in a theoretical manner, consider or discuss matter alone, and force alone; nevertheless, we can have no real or practical conception of the one without the other. We can have no knowledge whatsoever of force except through matter, nor any conception of matter except by force. It is by the thorough realization of these self-evident truisms, deduced from the universal experience of humanity, that modern thought has succeeded in breaking away from the older method of trying to consider matter as such. and force as such, without necessary reference one to the other. It is also very clear to any but the most superficial, that we have no conception, nor can have any, of what either matter or force are *per se*; but that we know them both by their results upon our senses only; and further, that so far as we are concerned at least, the two are necessarily inseparable.

All bodies which our senses make known to us are matter, and we can only conceive of such bodies as having *extent* or *size*, from which it follows that an essential quality of matter is *impenetrability*. By "extent" or "size," we mean the quantity of space which a body may fill; and by "impenetrability" we mean that property which excludes all other material from the occupied space. For it is evident that no two portions of matter can be in the same place at the same time. We have this exemplified by a nail being driven in a piece of wood, or a stone being sunk in water; as the nail enters *only* by forcing the particles of wood apart, and in the same way the stone pushes the particles of water away from the space it fills up. This is called *displacement*, and goes to demonstrate impenetrability, which really means that the ultimate particles or atoms of matter are perfectly solid or indivisible. Now although matter is thus clearly not infinitely divisible, as was thought by some of the Greek philosophers, and as reasoned even in this day by some amongst us, yet it is to us, indefinitely so; which will be best illustrated by a few examples of divisibility. Gold can be hammered out into leaves so thin that 290,000 of them only occupy an inch in thickness. A single ounce of silver, plated over with eight grains of gold can be drawn out into wire by existing machinery, two miles and a half in length, as near as possible; and yet every part of the wire will be covered completely with gold. In that way the gold of a sovereign can be made to stretch over a distance of 35 miles. There is a kind of spider so small that a thousand of them would only take up the space of a full grown common spider, and yet although so small, the threads they spin are each composed of about four thousand separate strands.

Again, animalculæ are known so small that a million of them would be no larger in bulk than a grain of sand, and yet they have the necessary organs of life, and some of them even live by preying upon animals less than themselves.

We find liquids have this same capability of indefinite divisibility. Most of us as boys have assisted at the amusing operation of blowing soap bubbles; but we did not perhaps then know, and some even yet may not be aware, that these can be blown to so thin a film of soapy water, that 2,600,000 would only equal an inch in thickness, and yet every part of such film is composed of soap as well as of water. Theoretically this division of matter could go on until we arrived at the last or ultimate particles or atoms of matter, after which no further division is possible, for if matter were infinitely divisible, it would surely cease to be impenetrable.

For the better understanding of this, it is necessary to see clearly in what and where this impenetrability of matter consists. The fact of the nail going into wood, and the stone sinking into the water, shows at once that matter in *masses* is *not* impenetrable, but is really composed of exceedingly small particles, each of which is impenetrable, or perfectly solid. And as matter is entirely composed of these particles it follows that matter in the aggregate is impenetrable in this sense. Any apparent contradiction in this is resolved when we state that it is the *forms* of matter alone which are penetrable and not matter itself.

We now advance a step, and consider the mechanical constitution of material things, in which it may be boldly stated that no two atoms ever touch each other. But that these particles are held at varying distances according to the conditions of their force or motion, just as surely as the relative distances are established and controlled between the heavenly bodies.

It indeed necessarily follows that to render the forms of matter capable of penetration they should thus be composed of particles already separated from each other, and that every substance in nature will, therefore, be *porous*. This not only appears necessary to the intellect but is also demonstrated by experiment, which is the true touchstone for the philosopher's theories and reasonings.

All persons have observed the fact that some bodies are heavier than others, and that there are some which are palpably porous. Now the heavier bodies are those which contain more particles of matter in a given external size; or in other words, in which the spaces or pores between the atoms are smaller. The less the pores the closer are the atoms, and the greater is the quantity of matter in a given measurement. It is easy to comprehend the porosity of a piece of sponge, but not so easy that of a piece of iron. Still it is simply a matter of *degree*. In the iron the pores being less, the atoms are already closer together; but iron may be reduced in bulk by being hammered, which process simply forces the particles of the metal still closer together, thus lessening the spaces between them. It may be asked by some reader non-scientific, what proof we have that these dense substances are really porous? Well, let us take gold as being a very dense metal indeed. As far back as the year 1661 A.D., gold was demonstrated to be porous in Florence. A hollow globe of gold was filled with water, and then subjected to pressure, which forced the water through the pores of the metal, and caused it to lie like dew-drops all over the outer surface of the globe. A common experiment, proving the porosity of glass, is made by putting a little water in a glass bottle, hermetically sealing up the stopper, and suspending it with a string for a number of months, at the end of which time the water is found to have disappeared. Again, quicksilver confined in a vessel of lead or gold, will escape through the pores of the metal, and we all know that water will pass through wood in the direction of its fibres.

At the time of the Florence experiment, as the water was thought not to yield to the pressure applied, it was then believed to be incompressible; but later experiments prove to the contrary, and show that it loses about one-twentieth of its bulk under a pressure of 15,000 lbs. to the square inch. In fact, given porosity, it follows that all forms of matter are theoretically at least compressible. We say theoretically with regard to compression, because it is obvious that to compress one form of matter we must make use of another form of matter to operate upon it, and that the one which has the least power of resistance gives way the most of the two. So that practically we may arrive at the densest form of matter in existence, in which case we might not possibly find another which would *appreciably* demonstrate its compressibility.

We are here brought face to face with perhaps one of the most wonderful and mysterious facts of nature, which seems to place the human mind in a rather difficult dilemma. For while on the one hand it is clear that if the particles of matter really did touch each other, compression would be impossible; yet on the other it is equally clear that if they never touch each other, we never touch or have any direct cognizance of matter at all. And really this latter is truly so, it being only the force or motion of matter which is communicated in some, as yet, not understood manner from one particle to another. There is, in fact, an attraction of the particles of matter at minute distances which corresponds to the action of the law of gravitation acting at great distances. The mystery, however, remains as to *how* force is communicated through apparently empty space. It also becomes clear that we have no *direct* consiousness of matter at all but only of force, which by a mental process is made to do duty for the supposed existent solid universe.

Having built up all forms of matter from innumerable but separated atoms, it becomes necessary to endue each atom with whatever forces or properties we find in the mass. For as we never find any exemplification of a force except through matter, so every ultimate atom of that matter is equally capable of exemplifying the force. This has been most beautifully illustrated by means of a magnetized bar of steel. If we take such a bar we find it imbued with a force of a dual nature apparently, one end pulling and the other repelling, as shown by its north and south magnetic poles with a neutral point between. Now if we cut this bar in half we find that each portion has become a separate magnet, having a north and south pole and neutral centre like unto the first. As this multiplication of magnets will go on to the smallest divisions of the bar which can possibly be made, it becomes certain that it would continue to so go on were it possible to reach the last possible theoretical separation necessary to arrive at the ultimate particles already referred to.

It is much easier to many persons to endue each separate atom with *some* forces than with others. Take for example *elasticity*, that force existing in certain substances which tends to re-act upon pressure. Here it is very clear that the work must be distributed equally amongst all the particles. The same may be said of the force of *cohesion*. upon which depends the task of holding particles one to another.

As in the case of the bar magnet we have an example of *attraction* and *repulsion*. so it would appear that all forces are forms of either one or the other of these two.

Gravitation, cohesion, chemical affinity, magnetism, appear to furnish examples of the one kind of force, while heat, mechanical motion, electricity, vital action illustrate the other.

In the attraction of cohesion we have a force which powerfully draws the particles of the substance to each other, but only up to a certain point, when they are met or balanced by a repulsive force, which prevents the atoms from rushing together absolutely and becoming a really solid lump. And it is just to this meeting of opposing forces that the different densities of forms of matter are due. The attraction of cohesion commences to operate appreciably only at insensible distances, which is the reason why if we break a stone or a piece of iron they refuse to hold together again because we are not able to restore the atoms to so close a union as they had before disturbance or breakage. It is more difficult to break a piece of iron than a piece of wood, for the reason that cohesion (which principally determines the strength of materials), is greater between the particles of iron than between those of wood. And this is mainly because the particles of iron are in closer contact, inasmuch as the attraction of cohesion increases to an enormous degree as the atoms approach each other more closely. Liquids have very little cohesion, and gases —as such—have none at all, for which reason their particles are the most easily separated. It is this power of cohesion which causes drops of dew on vegetables, tears on the cheeks, and a drop of water on the finger end to assume the shape of a globe, as each particle of the water tries to get as near as possible to the centre one, which can only be attained in the globular form. If we get two polished pieces of plate glass, brass, or marble, and rub them together, they will be found to adhere to each other so much as to require some considerable force to pull them asunder. This is because they are brought sufficiently near to come within cohesive action. Fresh cut pieces of lead will hold together in the same way, especially if pressed with a twisting motion. And as this occurs wherever the separation may take place, we may conclude that with cohesion as well as with elasticity and magnetism, each separate atom is endued with these properties or forces, and that there is no exhibition of these forces except through the intervention of what we understand or recognise as matter.

W. G.

(To be continued.)

THE DUST IN THE ATMOSPHERE.

By Dr. Assman, of Magdeburg.

Every one has noticed that when a ray of sunlight streams through a dark room, the air that otherwise seemed pure is seen to be inhabited by millions of very small particles. These little bodies are all embraced under the general name of "atmospheric dust."

There is a considerable difference in the general properties of this dust both in size and shape, as well as in weight. In size the particles of dust vary from several millimetres in the large flakes of soot from our factories, or the pieces of carbonised vegetable particles that are carried aloft in burning over swamps, down to the almost immeasurable particles that are designated by the term "cosmic dust," and probably result from the combustion of meteorites. They do not exceed in extent the ten-thousandth part of a small snow crystal.

If water from freshly fallen snow be evaporated under the microscope, we discover in it particles that derive their origin from all three of the natural kingdoms, animal, vegetable, and mineral.

Floegel, for example, found, in such cases, living infusoria and algæ, bacilli and micrococci, mites, diatoms, spores of fungi in immense numbers; also fibres of wool, mouse hairs, pieces of butterfly wings, skins of the larvæ of insects, cotton fibres, pieces of grass seed, bits of grass, epidermis, pollen grains, rye and potato flour, grains of quartz, minute pieces of roofing tiles, with bits of iron and coal.

The weight of the particles is limited by the possibility of their being sustained and floated on the currents of air. The larger their surface and the less the weight, the longer they will continue to float in the atmosphere.

Dust can be raised only by mechanical force, and this force is the moving air. If the motion of the air is horizontal, the quantity of dust lifted from the ground is comparatively small, particularly if the inclination of the surface varies but little from the horizontal. If the horizontal motion of the air is changed by a vortex or whirlwind into an ascending one, it raises a much greater quantity of dust. Those regions that have few or no plants in them are specially favourable to formation of ascending currents of air, in consequence of their being strongly heated by the sun's rays. But these very regions are most frequently covered with a fine grained light soil that is easily carried off by the wind, so that we may consider our deserts as the chief source of the atmospheric dust.

It has long been known to seamen who sail in that portion of the world, that off the west coast of tropical Africa the atmosphere is often filled with a thick cinnamon-coloured dust, so that the coast is scarcely visible at a distance of five (English) miles. This dust consists chiefly of fine quartz sand, and of still finer yellowish detritus, mixed with very numerous organic forms. Hellman has proved that the furnace which makes this "trade dust" is western Africa. The rain of dust thus formed often lasts ten days, and extends several miles from the spot where it originated.

In many cases masses of dust are precipitated from the atmosphere in form of rain, snow, or hail; hence snow and rain water not unfrequently have a yellowish red colour.

The phenomenon known as "rain of sulphur" depends upon an admixture of pollen with the rain.

Volcanoes furnish a second source of atmospheric dust. During the eruptions huge volumes of ashes and fragments of rocks are carried up into the air and borne to a great distance. The swamp-burning common in north-western Germany (and the forest fires in America) cause the formation of large quantities of dust.

Fires for domestic and manufacturing purposes contribute a large percentage to the atmospheric dust. It we consider that in London over seven million tons of coal are consumed annually, and in the whole of England fifty million tons, and that the products and residues of this combustion are for the great part carried into the air, it will be possible to form some conception of the quantity of dust derived from this source.

Finally we have to mention cosmic dust, which is referable to meteorites.

Concerning the actual quantity of dust floating in the air, Tissandier found in the air of Paris, after a week of dry weather, that there were 23 milligrammes in a cubic litre (or about 1 grain to 100 cubic feet). After a heavy rain there was about one-fourth as much (6 milligrammes to 1 litre).

The effect of the atmospheric dust is to diminish the amount of light and heat received from the sun, in the first place, and in the second to condense the aqueous vapours. An English investigator maintains that without dust no clouds could exist, no rain be formed; that dust is the nucleus on which vapours are condensed. Whether he is correct, farther research must decide.

The effect of atmospheric dust is of a manifold nature. Many plants owe their fertilisation to the winds which carry the fructifying grains of pollen. But the moving air also bears along with it a number of germs that cause plant diseases, such as rust, mildew, and blight. Animal bodies suffer in two ways from dust, either by the mechanical irritation of delicate organs, or by infection. In the latter respect the recent investigations of Pasteur, Naegeli, Kock, &c., render it exceedingly probable that all infectious diseases are due to the introduction into the system of a specific living germ of disease.

Hence the dust of the atmosphere is a factor which, in a meteorological and morphological, as well as phainological and hygienic aspect, exerts an important influence on our ball of earth and its inhabitants. Its investigation and study is still in its infancy and will certainly bring to light many other very important results.—*Chemiker Zeitung.*

THE EDINBURGH WATERWORKS.

By Alexander Leslie, M. Inst. C.E.

A paper on the above subject was read before the Institution of Civil Engineers.

The water-supply of Edinburgh was derived in almost equal portions from two main sources, the Pentland Hills and the Moorfoot Hills. In 1621 an Act was passed by the Scottish Parliament for the introduction of the first gravitation supply of water, previous to which time the inhabitants had to depend entirely upon wells. This supply was derived from Comiston Springs, about three miles from Edinburgh. It was introduced in 1681, and amounted to about 135,000 gallons per day.

An additional supply was brought in nearly twenty years later. Again, a further supply was introduced from the east end of the Pentland Hills in 1761. After several reports from Mr. John Smeaton, Mr. Thomas Telford, and others, an Act was obtained for introducing the water of the Crawley Springs, the works for which were completed in 1822. By means of this a supply of above 2,500,000 gallons per day throughout the year was rendered available, at a cost of £229,000. This scheme included the construction of the Glencorse Reservoir, and the laying of a pipe 8½ miles in length and 15 inches in diameter. Previous to the introduction of this water, the works were handed over by the town to a Company, who administered the water affairs of the city until 1870. The next application to Parliament was in 1843, when the Bavelaw, Listonshields, and Black springs on the north side of the Pentlands, were introduced. This work was completed in 1848, giving an additional supply of 2,000,000 gallons per day at a cost of £100,000. The Act also included the construction of the Threipmuir and Harlaw reservoirs for compensating the water of Leith and Bavelaw burn for the abstraction of the spring water. In 1847 an Act was obtained to construct Clubbie Dean, Torduff, Loganlea, and Bonally reservoirs, and also to increase the capacity of Glencorse by raising it four feet. In 1856 another Act was passed, authorising the introduction of the Colzium springs, and the construction of a compensation reservoir at Harperrig, on the water of Leith. A still further supply was obtained from the Crosswood springs, an Act for which was passed in 1863, and this included the construction of a compensation reservoir on the Crosswood burn. The water was introduced in 1868, and this was the last work carried out by the Water Company. The total available amount for the district of Edinburgh, Leith, and Portobello was about 8,000,000 gallons per day, which, at that time, was equal to 34 gallons per head per day, for the then estimated population of 230,000. About 14 per cent. of this was used for manufacturing purposes, and the total cost of the works, up to that time, was about £500,000.

An Act of Parliament was passed in 1869, transferring the water works from the Company to a trust composed of representatives from Edinburgh, Leith, and Portobello. The trust came into power on Whit-Sunday of the following year. Their first proceedings consisted in an application to Parliament for power to introduce the water of St. Mary's Loch, which Bill, after having passed the House of Commons, was ultimately rejected by the House of Lords. The opinion of the ratepayers was then taken as to the proper course to pursue by means of a plebiscitum, and it was determined to apply to Parliament for power to introduce water from the Moorfoot district. Plans were lodged for this Bill in the autumn of 1873, and Parliamentary sanction was obtained for it in the following session. The water shed of the Moorfoot district consists mainly of the Moorfoot Hills, forming a portion of the long band of Silurian uplands which stretch across Scotland, from St. Abbs Head to Portpatrick, and being a satisfactory gathering-ground for obtaining water for domestic supply. This scheme consisted in the utilisation of a drainage-area amounting to 14,500 acres, of which 6,131 acres were included in the portion of the water-shed of the Gladhouse burn, above the site of the reservoir of that name, 1,337 acres formed the drainage-area of the Tweeddale burn; these, together with Portmore Loch, with its drainage-area of 610 acres, were the portions available for town supply. The scheme was laid out on the assumption that compensation should be provided in the proportion of one-third of the yield of the district operated on, leaving two-thirds of the yield for town-supply, and reservoirs had been provided with storage equal to six months of the annual yield. Gladhouse reservoir had a capacity of 1,700,000,000 gallons, with a surface-area of 399 acres, and its greatest depth was 68½ feet. The crest of the waste-weir was 150 feet long, and the weir cost was £63,400, or £231 per 1,000,000 cubic feet of storage. Into this reservoir the flood waters of the Tweeddale burn were conducted by a segmental open aqueduct formed of concrete, which cost £12,000. A reservoir was constructed on the site of Portmore Loch, by means of which its surface-area was increased from 82 to 106 acres, and an available depth of water of 10 feet was obtained, at a cost of £12,500. The water from this reservoir was conveyed by a fire-clay pipe, 24 inches in diameter, to a measuring-cistern below Gladhouse embankment, from which it, along with the water from Gladhouse reservoir, was led towards Edinburgh by a conduit, 4 feet 6 inches by 3 feet, 3 miles in length, which discharged into a circular well 12 feet in diameter and 16 feet deep. At this point pressure was put on to the main pipe which led to Edinburgh; the pipe was partly 24 inches, and partly 22 inches in diameter, and was 8⅓ miles long. Several important works, such as bridges and tunnels, occurred on the line of this track. There were also various branch-pipes for the supply of the districts lying to the east of this, including Dalkeith, Musselburgh, Gilmerton, &c. The water was discharged into a large service reservoir, constructed at Alnwick Hill within three miles of Edinburgh, at which place the purification filters had also been erected. The service-reservoir had an area of five acres; it was 900 feet long, 240 feet wide, and contained 20,000,000 gallons. There were four filter-beds, fed by an arrangement of piping, which led away the water from a regulating-tank constructed on the lower side of the main embankment of the service-reservoir. These filter-beds were each about half acre in extent, and were designed to pass 9,000,000 gallons of water a day, supposing three of them to be working, and the remaining one being cleaned. The water was drawn from these filters through fire-clay pipes varying from 6 inches to 22 inches in diameter, and was admitted into a clear-water reservoir through a regulating-well, by means of which the rate of filtration could be increased or diminished. There was also a pipe by which the water could be admitted direct from the service-reservoir without filtration. The clear-water reservoir had a capacity of 4,500,000 gallons. It was 335 feet in length and 120 feet wide. The outer walls were of ashlar masonry backed with rubble, and it was covered with brick arching carried by four rows of piers, each of which was 5 feet by 2½ feet in area. These piers supported four rows of longitudinal arching 15 feet span and 2½ feet wide, which were coped with springers of ashlar, from which rose the main arches forming the roof of the structure. The piers were founded upon ashlar blocks let into recesses in the concrete floor of the building. They were constructed of pressed composition bricks set in Portland-cement mortar. The longitudinal roof arches consisted of three rings of brick of 22 feet-span with a rise of 5½ feet, having a radius of 14 feet. Above the roof arches was a layer of Portland-cement concrete 6 inches in thickness, and between the haunches of the arches drain-tile pipes were laid to convey away the rain-water. The top was levelled over with earthwork and provided with ventilators and was dressed off and laid out as a garden. From this clear-water reservoir the water passed through a measuring tank, 40 feet by 22 feet. The pipe communicating between these two chambers was furnished with a swiftly-shutting sluice, by means of which the rate of discharge could be readily ascertained by observing the rate at which a float-indicator descended. The cost of the service-reservoir filters and clear-water tank was £66,000. To complete the scheme two compensation-reservoirs were required; one of them termed the Edgelaw reservoir, was constructed on the Fullarton burn, to compensate for the abstraction of the Tweddale burn and Portmore waters. This reservoir had a capacity of 275,000,000 gallons, a depth of 80 feet, and a surface-area of 37 acres; its cost was £35,000, being £795 per 1,000,000 cubic feet. The Rosebery reservoir was being constructed across the South Esk, about two miles below the site of the Gladhouse reservoir, and would have a surface area of 52⅓ acres, with a depth of 75 feet and a capacity of 381,250,000 gallons. It was estimated to cost £33,000.

The total cost of the water-supply of Edinburgh, amounting to 16,000,000 gallons a-day, was about £1,000,000.

ON SILICON.

It is known that platinum heated in a forge fire, in contact with carbon, becomes fusible. Boussingault has shown that this is due to the formation of a silicide of platinum by means of the reduction of the silica of the carbon by the metal. MM. P. Schützenberger and A Colson have produced the same phenomenon by heating to white heat a slip of platinum in the centre of a thick layer of lampblack free from silica.

The increase in weight of the metal and the augmentation of its fusibility were found to be due, in this case also, to a combination with silicon. As the silicon could not come directly from the carbon which surrounded the platinum, MM. Schützenberger and Colson have endeavoured to discover under what form it could pass from the walls of the crucible through a layer of lampblack several centimetres in thickness, in spite of a volatility amounting to almost nothing under the conditions of the experiment. They describe the following experiments as serving to throw some light upon the question:—

1. A thin slip of platinum rolled in a spiral is placed in a small crucible of retort carbon closed by a turned cover of the same material. This is placed in a second larger crucible of refractory clay, and the intervening space filled with lampblack tightly packed. The whole is then heated to white heat for an hour and a half in a good wind furnace. After cooling, the platinum is generally found to have been fused into a button, with a marked increase in weight due to taking up silicon, which has penetrated in the form of vapour through the walls of the interior crucible.

2. If, in the preceding experiment, the lampblack be replaced by a mixture of lampblack and rutile in fine powder, the slip of platinum remains absolutely intact, and does not change in weight. Thus the titaniferous packing recommended by Sainte-Claire Deville for preventing the access of nitrogen in experiments at high temperatures also prevents the passage of silicon. A mixture of carbon and finely divided iron is, on the contrary, ineffectual. These facts seem to indicate that nitrogen plays a part in the transportation of the silicon, as this is only prevented by the same means made use of in order to prevent the passage of nitrogen.

3. The volatility of free silicon at a high temperature is too slight to account for the alteration of the platinum at a distance. This can be shown by placing several decigrammes of crystallised silicon on the bottom of a small crucible of retort carbon, covering the silicon with a small flat disk of retort carbon upon which is placed the slip of platinum. The crucible, closed by its turned cover, is then enveloped in a titaniferous packing and kept at a brilliant white heat for an hour and a half. The metal is found to have only very slightly increased in weight, and its properties remain unaltered. This experiment was repeated several times with the same result. If, however, the crystallised silicon be replaced by powdered calcined silica, the platinum, placed upon the carbon desk, fuses and increases in weight, while the silica loses weight. The theory of these curious phenomena is very difficult to establish on account of the high temperatures which are necessary for their manifestation, but it may be concluded, at present, that nitrogen and probably oxygen also play some part in the transportation of the silicon across the intervening space, and the carbosilicious compounds recently described by MM. Schützenberger and Colson also take part in the phenomenon.—*Comptes Rendus*.

THE PRESSURE OF GASEOUS EXPLOSIONS.—MM. Mallard and Le Chatelier have contributed to the *Comptes Rendus* a note upon the instantaneous pressures produced during the combustion of gaseous mixtures. According to observations made by these experimentalists upon explosions of gas in long tubes, when a flame is propagated along a pipe containing a combustible gaseous mixture, there is a development of great pressure, which only lasts during a very short time. A pressure that will pulverise a glass tube three centimetres in diameter and three millimetres thick, so that the fragments shall be less than a millimetre in size, must be enormous; but the apparatus at the disposal of the experimentalists has not enabled them to measure it. It has been ascertained, however, that the shock is of extremely short duration. Photographs of an explosion under these conditions show that the ignited luminous gas is projected to a distance of three metres from the end of the tube in less than the one-thousandth of a second. The maximum pressure cannot exist longer than a few thousandths of a second. A similar effect has recently been found to attend an explosion of gas in a closed vessel. It has been discovered that the pressure obtained under these circumstances far exceeds, for a short time, that due to the temperature of combustion. With a mixture of oxygen and hydrogen the shock exceeded by more than nine atmospheres the normal pressure due to the heat of combustion, although this excess was obtained only during a period of less than the ten-thousandth part of a second. This phenomenon is only observed with explosions of quickly burning mixtures, such as light carburreted hydrogen and hydrogen with oxygen.

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